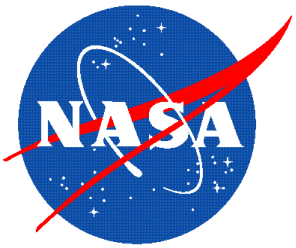

Ultra Long Duration Balloon Project

Design-To Requirements Document (DTRD)

October 16, 1998

820-ULDB-DTRD-002.0

Prepared By: _____
Date

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Approved : _____
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Head, Balloon Programs Office Date

ULDB Design-To Requirements Document

CHANGE CONTROL

Revision	Modifications	Date Released	Modified by
1.0	First Official Release	12-3-1997	David Stuchlik
2.0	Modifications to all Sections	10-16-1998	David Stuchlik

OUTLINE

ULDB Design-To Requirements Document

October 16, 1998

1. Introduction

This document defines the system requirements that the initial ULDB capability will meet.

1.1 Flight Duration

1.1.1 All flight and ground support systems shall be capable of supporting flight durations of up to 100 days.

2. Balloon Vehicle & Recovery Systems Requirements

2.1 Balloon Vehicle

2.1.1 Altitude

2.1.1.1 Science Users: The required and desired float altitudes are functions of the flight latitude and duration. Refer to Table One. The required minimum durations are one half of the desired minimum durations.

Latitude		Altitude		Desired Minimum Duration for primary science (days)
Minimum (°S)	Maximum (°S)	Minimum	Maximum	
43	43	35.05 km (115 kft)	35.05 km (115 kft)	54
43	43	32.00 km (105 kft)	32.00 km (105 kft)	78
35	35	35.05 km (115 kft)	35.05 km (115 kft)	88
35	43	35.05 km (115 kft)	35.05 km (115 kft)	62
30	43	35.05 km (115 kft)	35.05 km (115 kft)	65
30	43	33.53 km (110 kft)	33.53 km (110 kft)	80
30	43	32.00 km (105 kft) 6 hrs/day	35.05 km (115 kft) 8 hrs/day	74

Table One

2.1.1.2 Mission Users: Maintain float altitude above the troposphere.

2.1.2 Payload Weight

2.1.2.1 Science Users: Support an instrument mass of 540 kg. Support experiment masses up to 1000 kg.

2.1.2.2 Mission Users: Support balloncraft, flight train and other support elements.

2.1.3 Payload Attachment

2.1.3.1 Mission Users: Provide a means for attaching the experiment and carrier systems to the balloon.

2.1.4 Inflation & Launch

2.1.4.1 Mission Users: The balloon shall be designed to allow inflation and launch within operational limits.

2.1.4.2 Mission Users: The balloon shall be designed to allow for dynamic launching of the system with surface launch winds of up to 10 knots.

2.1.4.3 Mission Users: It is desired that the balloon be capable of being inflated in under 45 minutes. Required inflation time will be based on launch window analysis for the specific launch site.

2.1.5 Balloon Destruct

2.1.5.1 Mission Users: Adhere to the "Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas, February 1985".

2.1.6 Balloon Tracking

2.1.6.1 Mission Users: Adhere to the "Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas, February 1985".

2.1.7 Boxing, Shipment, and Storage

2.1.7.1 All Users: The balloon shall be boxed in a container suitable for both storage and shipment by land, sea, and air. Storage and exposure temperatures shall be from –10 C to 45 C. The packaging shall ensure that it does not degrade or damage the balloon.

2.2 Flight Trajectory Control Systems

2.2.1 Altitude Control

2.2.1.1 Altitude Variation

2.2.1.1.1 Science Users: The required and desired altitude variations are functions of the flight latitude and duration. Refer to Table One.

2.2.1.1.2 Mission Users: Adhere to the "Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas, February 1985".

2.2.1.2 Valving

2.2.1.2.1 All Users: The balloon system shall employ a valve or valves at the apex of the balloon. The valve(s) shall be sized to allow performance control of the balloon. The valve(s) shall be capable of ground command to open and close.

2.2.1.2.2 All Users: The valve(s) shall also be capable of auto-valving to maintain the desired pressure altitude and system pressure.

2.2.1.3 Ballasting

2.2.1.3.1 Mission Users: The balloon system shall carry ballast. The ballast hopper shall be have a commandable valve with a flow rate to allow performance control of the balloon. The ballast release system shall be capable of ground command to release the ballast.

2.2.1.3.2 Mission Users: The ballast system shall also be capable of auto-ballasting to maintain the desired pressure altitude

2.2.2 Ground Track Control

2.2.2.1 Science Users: The required and desired flight latitude variations are functions of the flight altitude and duration. Refer to Table One.

2.2.2.2 Mission Users: Prevent flight from travelling over restricted air space as defined by the State Department.

2.3 Recovery Systems

2.3.1 Science Users: There is no science user requirement for recovery. It is desired to return the Balloncraft to surface and recover with minimal damage.

2.3.2 Mission Users: There is no mission user requirement for recovery. It is required to safely return the Balloncraft and the balloon to the surface in accordance with the "Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas, February 1985". It is desired to recover the Balloncraft.

2.4 Flight Train

2.4.1 Balloncraft Support

2.4.1.1 All Users: The flight train shall support the Balloncraft in accordance with the "NSBF structural requirements for balloon gondolas".

2.4.2 Flight Termination

2.4.2.1 Mission Users: Flight termination shall be provided with at least two termination systems or devices that operate independently of each other.

2.4.3 Torsional Stiffness

2.4.3.1 Mission Users: Provide a torsional reaction mechanism for Balloncraft azimuth pointing systems if required by subsystem design.

2.4.3.2 Science Users: None

2.4.4 Visibility

2.4.4.1 Mission Users: Meet system visibility requirements in accordance with the "Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas, February 1985".

3. Balloncraft System Requirements

3.1 Power

3.1.1 Science Users: For all possible flight paths a DC power system shall provide continuous power to the Science Equipment. The power level shall be 122 watts for 18 hours per day, and 522 watts for six hours per day during nighttime. It is desired that a scaleable power system be developed which can support a maximum power of 800 watts continuous for science instrument use.

3.1.2 Mission Users – Gondola Power: For all possible flight paths, a DC power system shall provide continuous power to the balloncraft gondola support subsystems. The maximum wattage shall be 200 watts continuous.

3.1.3 Mission Users - Terminate Package and Commandable Apex Package Power (CAP): For all possible flight paths, a DC power system shall provide continuous power to the Terminate Package and the CAP subsystems. The wattage required shall be established depending on the packages' designs.

3.1.4 Backup Power: A redundant power system consisting of primary batteries shall provide power to the following subsystems for a minimum of seven days of operation: at least one three dimensional positioning device, at least one global

transmission device, at least one command receiver and decoder capable of firing the terminate pyrotechnics, and the terminate pyrotechnics circuitry.

3.2 Electrical Systems

3.2.1 Power Distribution

3.2.1.1 All Users: All balloncraft subsystems and experiment subsystems shall be independently power switched. Each subsystem power bus shall have short circuit protection. Each power switch shall be monitored.

3.2.2 Pyrotechnics

3.2.2.1 Mission Users: Pyrotechnics and circuitry for activation of pyrotechnics shall be provided for termination and parachute separation.

3.3 Telemetry

3.3.1 Global Downlink

3.3.1.1 Science Users: During routine operations for the duration of the flight, science instrument and housekeeping data shall be transmitted from the balloon to the Operations Control Center (OCC). The bit rate capability shall be a minimum of 9 kbps. It is desired that the bit rate capability shall be a minimum of 50 kbps.

3.3.1.2 Mission Users: During routine operations for the duration of the flight, Support Subsystem Housekeeping data, Engineering data and Mission Operations data shall be transmitted from the balloon to the OCC. This data shall be updated every 60 seconds or less. The effective bit rate shall be less than or equal to 100 bps and the amount of data shall be less than 1000 bytes.

3.3.1.3 Backup Telemetry Downlink: One of more backup global telemetry downlink systems shall be provided. There is no minimum required bit rate.

3.3.2 Global Uplink

3.3.2.1 Science Users: During routine operations for the duration of the flight, a method for sending science commands from the OCC to the balloon shall be provided. Command period frequency shall be a minimum of 4 times per day, and the command period duration shall be a minimum of 10 minutes (mission specific). The minimum command bit rate shall be 100 bps.

3.3.2.2 Mission Users: During routine operations for the duration of the flight, at least two global uplink systems shall provide a method for sending Mission Operations commands from the OCC to the balloon. At least one of the uplink telemetry systems shall provide the command period frequency, duration and bit rate specified in section 3.3.2.1. At least one of the uplink telemetry systems shall provide an emergency command capability for Mission Critical functions (i.e. terminate). The emergency command capability shall be available continuously during flight, and the command shall be received less than 10 minutes after initiation at the OCC. There is no minimum required bit rate.

3.3.3 Line of Sight Downlink

3.3.3.1 Science Users: During ground checkout, flight line checkout and during the period after launch when the balloon is within direct line of sight of the launch site, a downlink telemetry system will provide data transmission to a receive system at the launch site. The telemetry will include science instrument and housekeeping data at a minimum bit rate of 9 kbps.

3.3.3.2 Mission Users: During ground checkout, flight line checkout and during the period after launch when the balloon is within direct line of sight of the launch site or the terminate command equipment, a downlink telemetry system will provide data transmission to a receive system at the launch site or where the terminate ground station equipment is. Redundant downlink transmitters shall be provided.

3.3.4 Line of Sight Uplink

3.3.4.1 Science Users: During ground checkout, flight line checkout and during the period after launch when the balloon is within direct line of sight of the launch site, an uplink command telemetry system will provide command reception from the command ground station equipment. The minimum bit rate shall be 100 bps.

3.3.4.2 Mission Users: During ground checkout, flight line checkout and during the period after launch when the balloon is within direct line of sight of the launch site or the terminate command ground station equipment, an uplink command telemetry system will provide command reception from the command ground station equipment. The minimum bit rate shall be 100 bps. A minimum of two line of sight command receivers shall be provided in the gondola. A minimum of two line of sight command receivers shall be provided in the terminate system.

3.4 Data Handling

3.4.1 Data Acquisition

3.4.1.1 Science Users: Science Instrument and Science Housekeeping data shall be acquired by the balloon craft flight computer for processing, archive and transmission. The interface for the transfer of data shall be MIL-STD-1553 and the bit rate of the data shall be a minimum of 9 kbps.

3.4.1.2 Mission Users: Support Subsystem Housekeeping data, Engineering data and Mission Operations data shall be acquired by the balloon craft flight computer for processing, archive and transmission. This shall include data from the gondola, from the terminate system, and from the CAP. Analog data acquisition, discrete digital data acquisition, and data acquired from subsystems in subsystem-specific interfaces shall be supported. The overall mission users' effective bit rate shall be 100 bps or less.

3.4.2 Data Archive

3.4.2.1 All Users: All data and commands received by the flight processors shall be stored on-board. The required amount of storage shall be 10 GB. It is desired to provide 50 GB of storage. A separate, independent data storage subsystem shall be provided for each flight processor.

3.4.3 Data and Command Processing

3.4.3.1 All Users: Redundant flight processors are required. All data acquired by the flight processors shall be formatted for archive and transmission, archived, and transferred to all downlink telemetry systems. The ability to playback the archived data into the downlink telemetry systems shall be provided. The ability to transfer a subset of mission users' data to the instrument flight processor shall be provided. Data compression is desirable but not required. All commands received by all uplink telemetry systems shall be processed by the data processor. Processing of science commands shall consist of recognition of command destination, error checking, logging of command, command echo, and forwarding of command to the recognized

destination. A backup command decoder independent of the flight processors capable of decoding commands from at least one of the uplink telemetry systems shall be provided.

3.4.4 Command Execution

3.4.4.1 Science Users: Science commands shall be transferred to the science instrument for execution. The interface for the transfer of data shall be MIL-STD-1553 and the bit rate of the data shall be a minimum of 100 bps.

3.4.4.2 Mission Users: Hardware capable of providing discrete command outputs (i.e. open collector outputs) and timed command outputs shall be provided. Three command execution subsystems shall be provided – one for each flight processor, and one for the backup command decoder.

3.5 Sensors

3.5.1 Altitude

3.5.1.1 Science Users: Vehicle pressure altitude shall be included in the downlink telemetry data for science use. Pressure altitude shall be transferable to the on-board science computer using a 1553 interface and format. Pressure altitude accuracy shall be one percent.

3.5.1.2 Mission Users: Vehicle pressure altitude shall be included in the downlink telemetry data for mission operations use. Pressure altitude accuracy shall be plus/minus 0.9 km (three thousand feet) at altitudes above 18.3 km (60 kft), and plus/minus 0.3 km (one thousand feet) at altitudes below 18.3 km (60 kft). Mission users require a pressure altitude measurement that will be converted to kft using the standard atmosphere model.

3.5.2 Ground Track

3.5.2.1 Science Users: Vehicle position (geodetic latitude and longitude) shall be included in the downlink telemetry data for science use. Geodetic latitude and longitude shall be transferable to the on-board instrument computer. Geodetic accuracy shall be within a 5.6-km (3.5-mile) radius.

3.5.2.2 Mission Users: Vehicle position (geodetic latitude and longitude) shall be included in the downlink telemetry data for mission operations use. Geodetic accuracy shall be within a 5.6-km (3.5-mile) radius.

3.5.3 Housekeeping

3.5.3.1 Timing

3.5.3.1.1 A time stamp (time code) will be included in the downlink telemetry for science and mission users. The accuracy of the time stamp shall be 0.01 seconds or better. The time stamp update frequency shall be 0.1 second. The time stamp shall be transferable to the on-board instrument computer.

3.5.3.2 Voltage, Current, and Component Temperature Sensors

3.5.3.2.1 Voltage, current and component temperatures shall be sampled at no less than once every 60 seconds. Accuracy of these measurements shall be 5 percent or better.

3.5.3.3 Mission Operations and Engineering Sensors

3.5.3.3.1 Ambient Air - Mission Users: Ambient air temperature shall be measured. The required minimum sample rate is once per minute. The required accuracy is +/- 0.1 ° C. Redundant sensors are required. The sensors shall be a minimum of 5 meters below the lowest point on the gondola.

3.5.3.3.2 Solar Visible – Mission Users: required sensor bandwidth 400 to 700 nanometers, desired sensor bandwidth 300 to 800 nanometers. The sensor shall be sun tracking in azimuth and fixed in elevation. The maximum required hemispherical beamwidth is +/- 70 degrees with a minimum equal to the angle of the sun from float altitude. The required minimum sample rate is once per minute. The desired accuracy is +/- 1 watt.

3.5.3.3.3 Albedo – Mission Users: Albedo shall be measured. The sensor shall be down looking. Bandwidth, sample rate and accuracy requirements are the same as the solar visible requirements. The desired hemispherical beamwidth shall be equal to the angle of the earth and atmosphere from float altitude.

3.5.3.3.4 Floor (down looking) IR – required sensor bandwidth 800 to 2500 nanometers. The sensor shall be down looking. The desired hemispherical beamwidth shall be equal to the angle of the earth and atmosphere from float altitude. The required minimum sample rate is once per minute. The desired accuracy is +/- 1 watt.

3.5.3.3.5 Canopy (sky) IR – The required sensor bandwidth is 800 to 2500 nanometers. The sensor shall be up looking and mounted on the top of the balloon. The required hemispherical beamwidth is between +/- 70 degrees and +/- 90 degrees. The required minimum sample rate is once per minute. The desired accuracy is +/- 1 watt.

3.5.3.3.6 Atmospheric IR – The required sensor bandwidth is 800 to 2500 nanometers. The sensor shall be mounted in the anti-sun direction, and mounted in elevation to sense the earth atmosphere and cold sky. The required hemispherical beamwidth is between 6 and 60 degrees, with lower beamwidth more desirable. The required minimum sample rate is once per minute. The desired accuracy is +/- 1 watt.

3.5.3.3.7 Earth Temperature IR – Mission Users: Earth temperature shall be derived from the Floor (down looking) IR measurement. The required accuracy is +/- 1.0 ° C.

3.6 Attitude Control Systems

3.6.1 Gondola Azimuth Pointing Control and Determination

3.6.1.1 Azimuth Control - Science Users: There is no science requirement for azimuth control. Implementation of the following modes of operation is desired:

3.6.1.1.1 Mode 1: Daytime and Nighttime: Continuous spinning at rates from 0.5 degrees per second to 6 degrees per second with a rate accuracy of +/- 20 percent.

3.6.1.1.2 Mode 2: Daytime: Scanning relative to the sun with a scan reference from 0 to 360 degrees from the sun, scan amplitude from +/- 10 degrees to +/- 60 degrees, and a scan rate of 1 degree per second to 6 degrees per second. Scan reference accuracy shall be one degree and scan amplitude and rate shall be accurate within +/- 20 percent.

3.6.1.1.3 Mode 3: Daytime: Pointing relative to the sun with an accuracy of one degree when the sun elevation is between the horizon obstruction and the balloon shadow obstruction.

3.6.1.1.4 Mode 4: Nighttime: Pointing relative to the moon with an accuracy of 10 degrees with the moon elevation is between the horizon obstruction and the balloon shadow obstruction.

3.6.1.1.5 Mode 5: Daytime and Nighttime: Pointing relative to true north with an accuracy of one degree.

3.6.1.2 Azimuth Control - Mission Users: If the UDLB power subsystem is based on solar tracking, sun-tracking azimuth pointing of the entire gondola shall be provided with an accuracy of +/- 5 degrees.

3.6.1.3 Azimuth Determination – Science and Mission Users: Azimuth shall be determined onboard with an accuracy of one degree. Azimuth data shall be transferable to the on-board science computer using a 1553 interface and format Azimuth data shall be provided in the downlink telemetry with a minimum update frequency of once per minute.

3.6.2 Gondola Elevation Control and Determination

3.6.2.1 All Users: Gondola elevation control and determination is not required.

3.6.3 Subsystem Azimuth Pointing Control and Determination

3.6.3.1 Science Users: Azimuth pointing control and determination of the science instrument(s) is not required.

3.6.3.2 Mission Users: Azimuth pointing control and determination of the support subsystems (i.e. solar collectors and antennas) shall be provided as needed with performance requirements established by specific subsystem design.

3.6.4 Subsystem Elevation Pointing Control and Determination

3.6.4.1 Science Users: Elevation pointing control and determination of the science instrument(s) is not required.

3.6.4.2 Mission Users: Elevation pointing control and determination of the support subsystems (i.e. solar collectors and antennas) shall be provided as needed with performance requirements established by specific subsystem design.

3.7 Cryogenics

3.7.1 Science Users: Cryogenic cooling is not required. Develoment of an electromechanical device capable of cooling science instrument detectors is desired. The target performance of the device is to cool a load of 4 watts to 80 Kelvin with a reject temperature of 40 degrees centigrade.

3.8 Thermal

3.8.1 Thermal Control

3.8.1.1 Mission Users: Thermal Control systems that will maintain the Ballooncraft subsystems and components within the operating temperature range of the components and subsystems shall be provided.

3.9 Mechanical Systems

3.9.1 Structures and Enclosures

3.9.1.1 All Users: Structure and enclosure design and fabrication shall be provided as needed in accordance with the “NSBF structural requirements for balloon gondolas”.

3.9.2 Deployment and Separation

3.9.2.1 Mission Users: Design, analysis, fabrication, test and flight support for mechanical deployment and separation shall be provided as required. Design, analysis, fabrication, test and flight support for the flight terminate separation fitting and the parachute separate fitting shall be provided as required.

4. Mission & Operations Requirements

4.1 Mission Planning

4.1.1 Trajectory Planning

4.1.1.1 Mission Users: Determine the probabilities of achieving mission duration and performance objectives.

4.1.2 Mission Safety

4.1.2.1 All Users: ULDB flight operations and procedures shall be conducted in accordance with “Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas".

4.1.2.2 All Users: Ground Safety, Payload Safety, and Occupational Safety plans will be executed in accordance with existing NASA Balloon Program safety plans or amended as required to satisfy unique ULDB requirements.

4.1.3 Launch Site

4.1.3.1 Mission Users: Select launch site to achieve mission objectives and in accordance with the “Safety Analysis Report for Balloon Programs Conducted by the National Scientific Balloon Facility Palestine, Texas".

4.1.4 International Agreements

4.1.4.1 Mission Users: Define and implement procedures and agreements required for international launch, flight and terminate operations.

4.1.5 Inter-Agency Agreements

4.1.5.1 Mission Users: Define and implement procedures and agreements required for inter-agency sharing of logistics and/or facilities and for inter-agency support of launch and/or recovery operations.

4.2 Integration & Verification

4.2.1 Facilities

4.2.1.1 All Users: Integration and testing facilities shall be provided to complete final assembly of balloncraft and to conduct full-up verification tests prior to shipment to the launch site. Floor space, electrical, Internet and telecommunications will be provided as required.

4.2.2 Telemetry Equipment

4.2.2.1 All Users: RF equipment shall be provided to support flight telemetry systems for both open-link and closed-link reception of the downlink (balloncraft data) signals and transmission of all uplink (balloncraft command) signals. Baseband equipment shall be capable of demodulating, decommutating, and bit synchronizing downlink data as required.

4.2.3 Monitor and Control Hardware & Software

4.2.3.1 Monitor Science Users: The Monitor and Control System (MCS) shall process science data received by the downlink telemetry systems. This processing shall include data storage and forwarding the data electronically to a local scientist provided ground computer.

4.2.3.2 Monitor Mission Users: Mission data received by the telemetry systems shall be displayed by the MCS in engineering units and stored as raw and converted units.

4.2.3.3 Control Science Users: The scientist shall have the capability to initiate science commands on the local science provided ground computer, which are forwarded electronically to the MCS. The MCS shall verify the science commands are valid and forward them to the uplink telemetry system with a delay of less than one second.

4.2.3.4 Control Mission Users: Mission users will be capable of initiating mission commands on the MCS. The MCS will verify the mission commands are valid and forward them to the uplink telemetry system with a delay of less than one second. Mission critical commands will take precedence over all other commands. Mission critical commands, to include termination, will be capable of being initiated only from the MCS terminal.

4.2.4 Other Equipment

4.2.4.1 All Users: Mechanical and electronic equipment required for assembly and verification will be provided. Hoist(s), fork lifts, machine shop equipment & tools, and electronic test equipment will be provided as required. Environmental test equipment will be provided as required.

4.2.5 Personnel

4.2.5.1 All Users: Personnel support required for assembly, operation, and verification will be identified.

4.3 Launch Site Operation

4.3.1 Facilities

4.3.1.1 All Users: Facilities at the launch site are required to accommodate balloon craft "pre-flight' preparations and verification, NSBF flight operations, and the Remote Operation Control Center (ROCC) ground station. Floor space, electrical, Internet and telecommunications will be provided as required.

4.3.2 Telemetry Equipment

4.3.2.1 All Users: RF equipment capable of providing open-link reception of all LOS downlink signals and transmission of LOS uplink signals shall be provided for ranges up to 740 km (400 nmi). Baseband equipment shall be capable of demodulating, decommutating, and bit synchronizing downlink data as required.

4.3.3 Monitor and Control Hardware & Software

4.3.3.1 Same as 4.2.3.

4.3.4 Other Equipment

4.3.4.1 Pre-Launch Checkout: Mechanical and electronic equipment will be provided as required in the balloon craft flight preparation area and on the flight line. Hoist(s), forklifts, machine shop equipment & tools, and electronic test as required.

4.3.4.2 Launch: A dynamic launch vehicle, balloon launch spool, trailers, and inflation equipment will be provided as required.

4.3.5 Personnel

4.3.5.1 Launch Site - All Users: Personnel support required for science and mission user flight readiness, launch operations, early (contingency) termination & recovery, and campaign management will be identified.

4.3.5.2 Operation Control Center - All Users: Personnel support required for science and mission user flight readiness testing and launch & flight monitoring will be identified.

4.4 Flight Operation

4.4.1 Facilities

4.4.1.1 All Users: A facility is required for support of the Operation Control Center (OCC) ground station, and flight monitoring & management. Floor space, electrical, Internet and telecommunications will be provided as required.

4.4.2 Telemetry Equipment

4.4.2.1 Terminal equipment for transmission and reception of data through the global communication system(s) will be provided at the Operation Control Center (OCC). No LOS equipment is required.

4.4.3 Monitor and Control Hardware & Software

4.4.3.1 Monitor Science Users: It is desired that science data received at the OCC be displayed locally. Science data received at the OCC will be stored locally. Storage amount is 10 GB for science users. Science data received at the OCC will be transferred electronically to a remotely located science provided ground computer.

4.4.3.2 Monitor Mission Users: Mission data received by the telemetry systems shall be displayed at the OCC in engineering units and stored as raw and converted units. Storage amount is 1 GB for mission users.

4.4.3.3 Control Science Users: The scientist shall have the capability to initiate science commands via science ground computers either locally at the OCC and/or remotely via Internet. These commands are forwarded to the MCS. The MCS shall verify the science commands are valid and forward them to the global uplink telemetry system immediately or at the beginning of the next scheduled uplink event.

4.4.3.4 Control Mission Users: Mission users will be capable of initiating mission commands on the MCS. The MCS will verify the mission commands are valid and immediately forward them to the uplink telemetry system or at the beginning of the next scheduled uplink event. Mission critical commands will take precedence over all other commands. Mission critical commands, to include termination, will be capable of being initiated only from the MCS terminal.

4.4.4 Other Equipment

4.4.4.1 Equipment required for support of mission objectives will be provided to include Local Area Network, Internet Connectivity, and communications systems as required.

4.4.5 Personnel

4.4.5.1 As per 4.3.5.2. In addition, flight mission and science management roles will be defined.

4.5 Termination & Recovery

4.5.1 Facilities

4.5.1.1 As per 4.4.1 for OCC operation. Remote facilities to support recovery operation will be provided as required.

4.5.2 Telemetry Equipment

4.5.2.1 Operational Control Center: As per 4.4.2.1.

4.5.2.2 Mobile Ground Station: Mobile RF equipment capable of providing open-link reception of flight critical data on all LOS downlink signals and transmission of terminate commands on all LOS uplinks will be provided. Open-link reception and transmission will be capable of 740 km (400 nmi) range. Included is baseband equipment for demodulating, decommutating, and bit synchronizing as required.

4.5.3 Monitor and Control Hardware & Software

4.5.3.1 Operation Control Center: As per 4.4.3.

4.5.3.2 Mobile Ground Station: Mission users will be capable of initiating all mission and flight critical commands. Mission data received by the telemetry systems shall be displayed in engineering units and stored.

4.5.4 Other Equipment

4.5.4.1 Other equipment necessary for termination and recovery will be provided to include vehicles and tools necessary to extract the balloon craft and balloon vehicle.

4.5.5 Personnel

4.5.5.1 Personnel required to conduct remote termination and recovery operations will be identified.

ACRONYMS AND DEFINITIONS

Assembly area	The facility at the launch site where the gondola is assembled and check outs are performed after shipping and prior to launch.
Balloncraft	All components and subsystems below the launch pin. Synonymous to the gondola in conventional ballooning terms.
BC Mission Ops subsystems	All NASA/GSFC/WFF Code 820 provided flight systems which are located below the launch pin and are required for mission operations.
BC	Balloncraft
bps	bits per second.
CAP	Commandable Apex Package
Carrier Systems	All NASA/GSFC/WFF Code 820 provided flight systems with the exception of the Vehicle and experiment specific support systems. Includes the flight train, the CAP, the ballast, and the electronic subsystems required for mission operations. See Table Two.
Code I	NASA/Headquarters Code I, which handles international relations.
Early float	The period of a balloon flight from launch until when the balloon travels beyond line of sight RF contact range from the launch site RF equipment.
EU	Engineering Units.
Experiment	The scientist-provided instrument and the balloncraft support systems which are provided to meet instrument requirements (instrument power, instrument data handling, balloncraft structure, etc.). See Table Two.
Flight line	The balloon launch area where the balloon is laid out on the ground cloth, the launch spool is positioned, the helium supply is positioned, and the gondola and launch vehicle are positioned.
kbps	kilobits per second.
kft	kilo-feet (thousands of feet).
km	kilometers
Launch Pin	The attachment device where the top of the balloncraft is attached to the launch vehicle.
LOS	Line of Sight.
MCS	Monitor and Control System.
nmi	Nautical Mile
OCC	Operations Control Center.
Ops	Operations
RF	Radio Frequency.
ROCC	Remote Operations Control Center.
Science Detector	The scientist-provided device(s) that observe, detect or measure.
Science Instrument	The scientist-provided equipment which includes the science detector and the detector support equipment (flight processor(s), high voltage supplies, etc.).
TBD	To be determined.

Vehicle — The main balloon and all components which are built into the balloon. See Table Two.

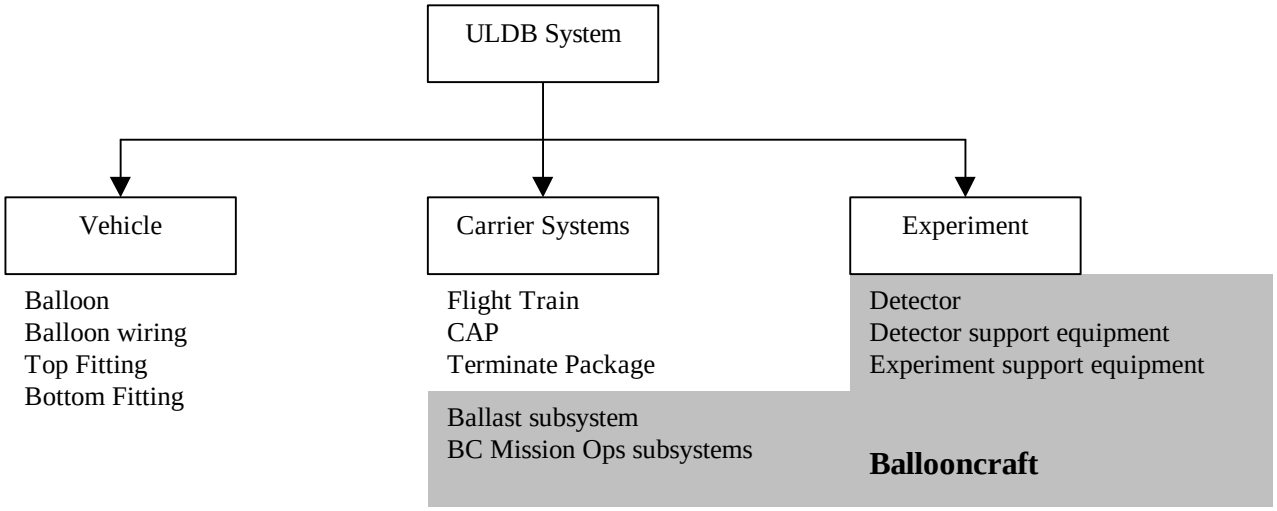

Table Two